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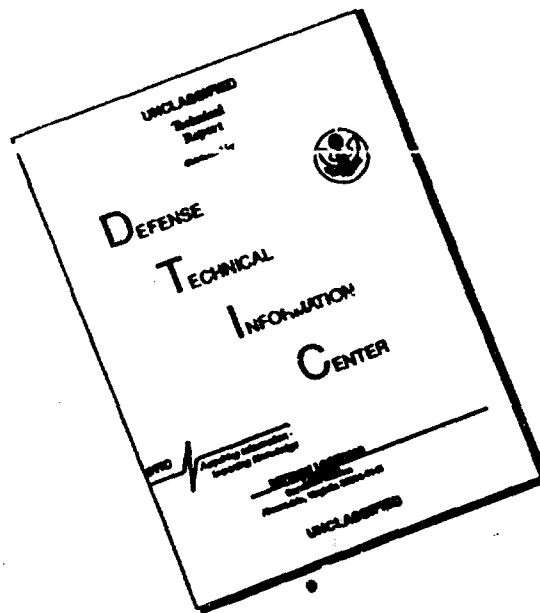
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GENERAL DYNAMICS | CONVAIR

Report No. 8926-094

Material - Finishes and Coatings - Wear Resistant

Abrasion Resistance

L. A. Mappus, J. C. George, E. E. Keller

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21 July 1959

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Reference: Mappus, L. A., George, J. C., Keller, E. E.,
"Abrasion Wear Preventive Devices In Vibrating
Faying Surfaces, Evaluation of," General Dynamics/
Convair Report MP 58-470, San Diego, California,
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*Per Second



A DIVISION OF GENERAL DYNAMICS CORPORATION

REPORT OF FP-50-470

DATE 21 JUL 1969

MODEL 30

REPORT NO. NP 58-470

MODEL: 30

GROUP Materials & Processes L.

REFERENCE

APPROVED BY E. F. Strong
E. F. Strong, Chief
of Structures & Materials Lab.

NO. OF PAGES 16

NO. OF DIAGRAMS 14

J. N. Sutherland, Grp. Engr.

REVISIONS

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ANALYSIS**PREPARED BY** Mappus**CHECKED BY** George/Keller/Sutherland**REVISED BY****CONVAIR**A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO**PAGE** 1**REPORT NO.** MP 58-470**MODEL** 30**DATE** 21 July 1959**INTRODUCTION:**

In order to prevent the abrasive wear in faying surfaces of primary structures or parts whose replacement would be costly, the design groups intend to install wear preventive devices between the primary structure and bolted on doors, panels, fairings, etc. This test request was originated to evaluate various wear preventive devices installed in clad aluminum alloy metallic joints and subjected to vibration.

OBJECT:

To evaluate, under simulated vibration conditions, various wear preventive devices installed in clad aluminum alloy faying surface joints.

CONCLUSIONS:

Of the 20 different wear preventive devices tested, Dacron Temp-R-Tape, manufactured by the Connecticut Hard Rubber Company, New Haven, Conn., was the best material tested for use in faying surface joints from the standpoint of wear prevention and ease of installation.

TEST SPECIMENS:

Twenty (20) different faying surface combinations were evaluated. In each combination, one surface was attached to, or a part of, an .040 inch thick sheet of 2024-T3 clad aluminum alloy. The other surface was attached to a 1.5 x 2 x 3 inch 2024-T3 aluminum alloy block. The faying surfaces are listed in Table I.

TEST PROCEDURE:

A photograph of the test jig is shown in Figure 1. The design of this machine made it possible to test sixteen (16) faying surface combinations simultaneously. A motor whose speed was controlled by a Variac, turned two cam wheels. Each cam actuated two rods, each rod moving 4 specimens. The rods were spring loaded to hold them against the cams. Loads were applied to each specimen by means of calibrated springs. Conditions set for this test were as follows: The motor speed was set at 850 RPM which was approximately fourteen (14) cycles per second; the cams were made to give an amplitude of vibration of .0625 inches; the springs were adjusted to give a pressure of 2.5 PSI on the faying surface joint.

Specimens without their own adhesive, were attached to the blocks and sheets by means of double faced Permacel No. 94 polyester tape. This method of attachment facilitated the removal and replacement of faying surfaces. When it was desired to eliminate a faying surface from test completely a metal sleeve was substituted for the block.



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SAN DIEGO

STRUCTURES & MATERIALS LABORATORY

REPORT CF 50-470

DATE 21 JUL 1959

MODEL 30

TITLE

REPORT NO. P 58-470

ABRASION WEAR PREVENTIVE DEVICES IN
VIBRATING PAYING SURFACES -
EVALUATION OF

MODEL: 30

PREPARED BY L. A. Mappus
L. A. Mappus

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GROUP Materials & Processes L.

CHECKED BY: J. C. George
J. C. George

W. J. George

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E. F. Strong, Chief
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Cf Structures & Materials Lx

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J. M. Sutherland NO. OF 6
J. M. Sutherland, Cng. Engr.

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REVISIONS

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ANALYSIS

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CHECKED BY George/Keller/Sutherland

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CONVAIR

A DIVISION OF CENTRAL DYNAMICS CORPORATION
SAN DIEGO

PAGE 1

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ANALYSIS**PREPARED BY** Mappus**CHECKED BY** George/Keller/Sutherland**REVISED BY****CONVAIR**A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO**PAGE 2****REPORT NO.** MP 58-470**MODEL** 30**DATE** 21 July 1959**TEST PROCEDURE:** (Cont'd)

The faying surface joints were dis-assembled periodically for inspection. Photographs of the faying surfaces were taken after 20, 100, 200, and 300 hours of testing. These photographs are shown in Figures 2 thru 9. Each hour of testing represents 51,000 cycles. Tests were stopped after 300 hours (15,300,000 cycles).

RESULTS & DISCUSSION:

Results are listed in Table II. Conditions of the faying surfaces are shown in Figures 2. through 9. The Figure numbers and positions shown in Table II refer to the location of the most severe condition of wear for each faying surface combination in the Figures. Positions in the Figures are numbered from top to bottom and left to right as follows:

| | |
|---|---|
| 1 | 5 |
| 2 | 6 |
| 3 | 7 |
| 4 | 8 |

Faying surfaces 1, 4, 5, 6, 10, 11, 19, and 20 were all eliminated because of galling. Faying surfaces 8 and 9 were not considered because it is not practical to keep the joints lubricated. Faying surfaces 2, 3, 7, 12, 14, 15, 16, 17, and 18 did not offer as much protection as 13 and, in addition, would be more difficult to install in the production shop.

ACKNOWLEDGEMENT:

The test jig was designed by Mr. Gerard DeVries of the Convair, San Diego, Engineering Department.

NOTE: Test data from which this report was prepared may be found in Engineering Test Laboratories Data Book No. 3004.

Table I
Faying Surfaces Tested

| Faying Surface No. | Block Surface | Sheet Surface |
|--------------------|---|---|
| 1 | .040 inch 2024-T3 Clad al.alloy | .040 inch 2024-T3 Clad al.alloy |
| 2 | .015 inch Nylatron GS (Molybdenum disulphide impregnated nylon) Mfg. by Polymer Corp; Reading Pa. | .015 inch Nylatron GS |
| 3 | .002 inch Polyester tape 3M Co. Tape # 853 | .002 inch Polyester tape 3M Co. Tape # 853 |
| 4 | .040 inch 2024-T3 Clad al.alloy Lubricated with ELF Lube Stick Mfg. by Aviation Lubricants Co; San Diego, Calif. | .040 inch 2024-T3 Clad al.alloy |
| 5 | .040 inch 2024-T3 al.alloy with .002 inch hard anodized surface Mfg. by Anachrome Corp; Southgate, Calif. | .040 inch 2024-T3 al.alloy |
| 6 | .040 inch 7075 al.alloy with .002 inch hard anodized surface Mfg. by Anachrome Corp; Southgate, Calif. | .040 inch 2024-T3 Clad al.alloy |
| 7 | .040 inch 2024-T3 al.alloy with .002 inch hard anodized surface Mfg. by Anachrome Corp; Southgate, Calif. | .002 inch Polyester tape (Nylar) 3M Co. Tape # 853 |

Table I (Cont'd)

| Paying Surface No. | Block Surface | Sheet Surface |
|-----------------------|--|--|
| 8 | Convair Spec. O-03021, Type II White epoxy enamel, Mfg. by Andrew Brown Co. Lubricated with ELF Lubestick | .040 inch 2024-T3 Clad al.alloy |
| 9 | Convair Spec. O-03021, Type II White epoxy enamel, Mfg. by Andrew Brown Co. Lubricated with ELF Lubestick | Convair Spec. O-03021, Type II White epoxy enamel Mfg. by Andrew Brown Co. |
| 10 | .040 inch 2024-T3 al.alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate, Calif. | .040 inch 2024-T3 al.alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate, Calif. |
| 11 | .018 inch 301 1/2 hard stainless steel | .040 inch 2024-T3 al.alloy with .002 inch hard anodized surface, Mfg. by Anachrome Corp. Southgate, Calif. |
| 12 | .015 inch Nylatron film Mfg. by Polymer Corp; Reading Pa. | .040 inch 2024-T3 Clad al.alloy |
| 13 | Dacron tape, Temp.-R-Tape DV (CVAC No.310282) Mfg. by Connecticut Hard Rubber Co; New Haven, Conn. | .040 inch 2024-T3 Clad al.alloy |

Table I(Cont'd)

| Faying Surface No. | Block Surface | Sheet Surface |
|-----------------------|--|---|
| 14 | .0065 inch Teflon Tape 3M Co. No. 549 | .040 inch 2024-T3 Clad al.alloy |
| 15 | .002 inch Polyester Tape 3M Co. No. 853 | .040 inch 2024-T3 Clad al.alloy |
| 16 | .031 inch Epoxy Laminate Mil-P-18177A, Type GEE | .040 inch 2024-T3 Clad al.alloy |
| 17 | .031 inch Polyester Laminate Mil-P-8013, Type I | .040 inch 2024-T3 Clad al.alloy |
| 18 | .031 inch Phenolic Laminate Mil-P-15035B, FEM | .040 inch 2024-T3 Clad al.alloy |
| 19 | .012 inch Type 301, 1/2 hard stainless steel, Mil-S-5059A | .040 inch 2024-T3 Clad al.alloy |
| 20 | Convair Spec. O-03021, Type II White epoxy enamel, mfg. by Andrew Brown Co. | Convair Spec. O-03021, Type II epoxy enamel (white) mfg. by Andrew Brown Co. |

Table II
Results of Tests

| Faying Surface No. | Hours Tested | Comments | Ref. Fig. No. & Position | Relative Rating |
|--------------------|--------------|---|--------------------------|-----------------|
| 1 | 210 | Control-discontinued after 210 hours because of severe galling | Fig. 8 Pos. 1 | Poor |
| 2 | 300 | Good abrasion resistance but not as easily installed as faying surface No. 13 | Fig. 8 Pos. 2 | Good |
| 3 | 300 | Same as above | Fig. 8 Pos. 3 | Good |
| 4 | 100 | Galling occurred even with lubrication | Fig. 4 Pos. 4 | Poor |
| 5 | 10 | Discontinued because of galling, substituted faying surface No. 10 | Not shown | Poor |
| 6 | 20 | Discontinued because of galling | Fig. 2 Pos. 6 | Poor |
| 7 | 300 | No advantage over faying surface No. 15 | Fig. 8 Pos. 7 | Good |
| 8 | 300 | Protected aluminum but may not be practical to keep surface lubricated | Fig. 8 Pos. 8 | Good |
| 9 | 200 | Same as above | Fig. 8 Pos. 4 | Good |
| 10 | 1 | Discontinued because of galling | Not shown | Poor |

Table II (Cont'd)

| Faying Surface No. | Hours Tested | Comments | Ref. Fig. No. & Position | Relative Reading |
|--------------------|--------------|--|--------------------------|------------------|
| 11 | 300 | Discontinued because of galling & fretting corrosion | Fig. 4 Pos. 5 | Poor |
| 12 | 300 | Clad aluminum scratched by Nylatron | Fig. 9 Pos. 1 | Good |
| 13 | 300 | Clad aluminum in excellent condition; Dacron fabric is only slightly worn. | Fig. 9 Pos. 2 | Excellent |
| 14 | 300 | Clad aluminum slightly scratched | Fig. 9 Pos. 3 | Good |
| 15 | 300 | Clad aluminum slightly scratched | Fig. 9 Pos. 4 | Good |
| 16 | 300 | In all three of these cases, the wear occurred on the fiberglass laminate. Clad aluminum not worn. | Fig. 9 Pos. 5 | Good |
| 17 | 300 | | Fig. 9 Pos. 6 | Good |
| 18 | 300 | | Fig. 9 Pos. 7 | Good |
| 19 | 100 | Discontinued after 100 hours because of wear and galling | Fig. 5 Pos. 8 | Poor |
| 20 | 200 | Galling | Fig. 9 Pos. 8 | Poor |

ANALYSIS

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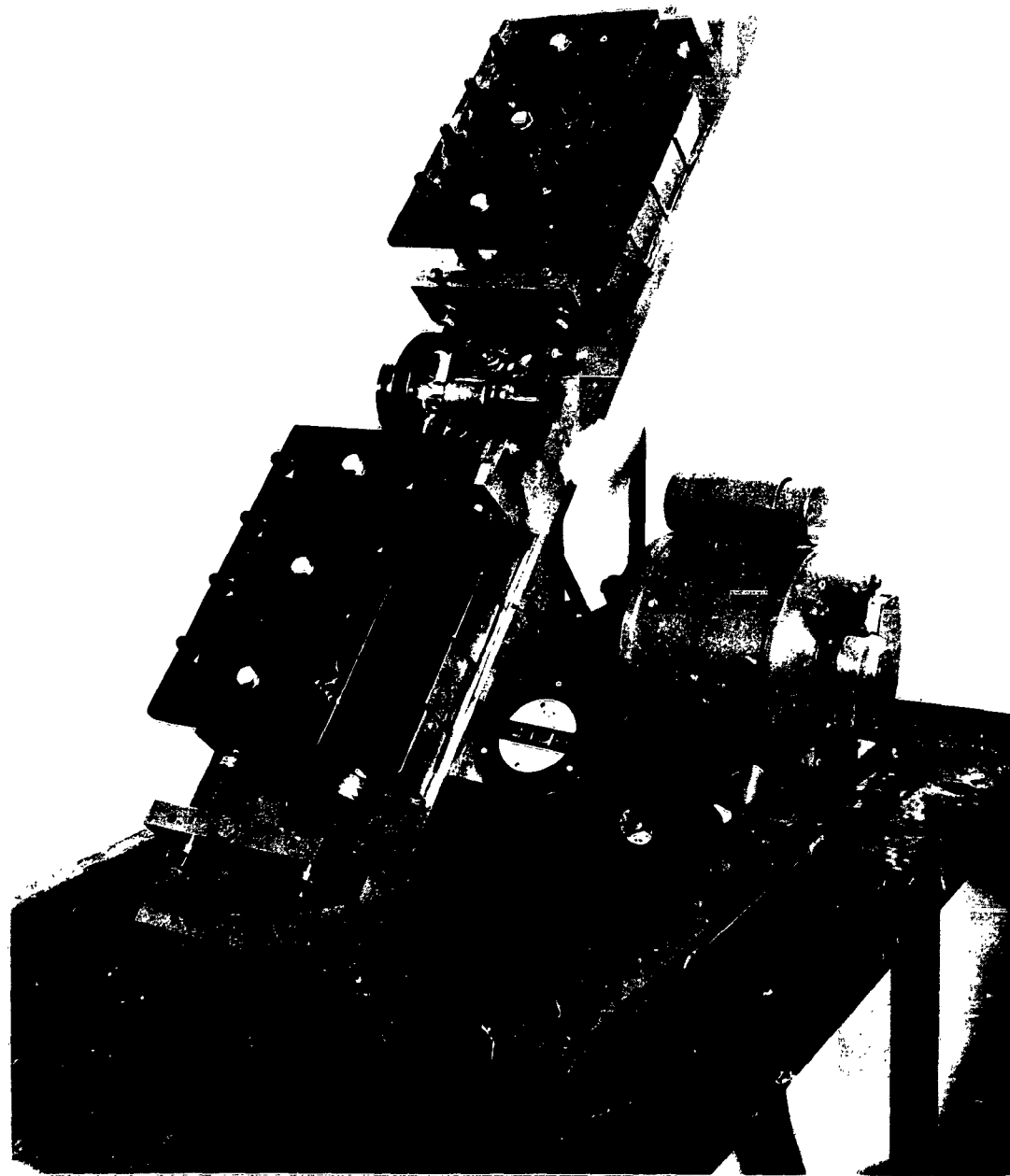


FIGURE 1

FAYING SURFACE ABRASION TEST JIG

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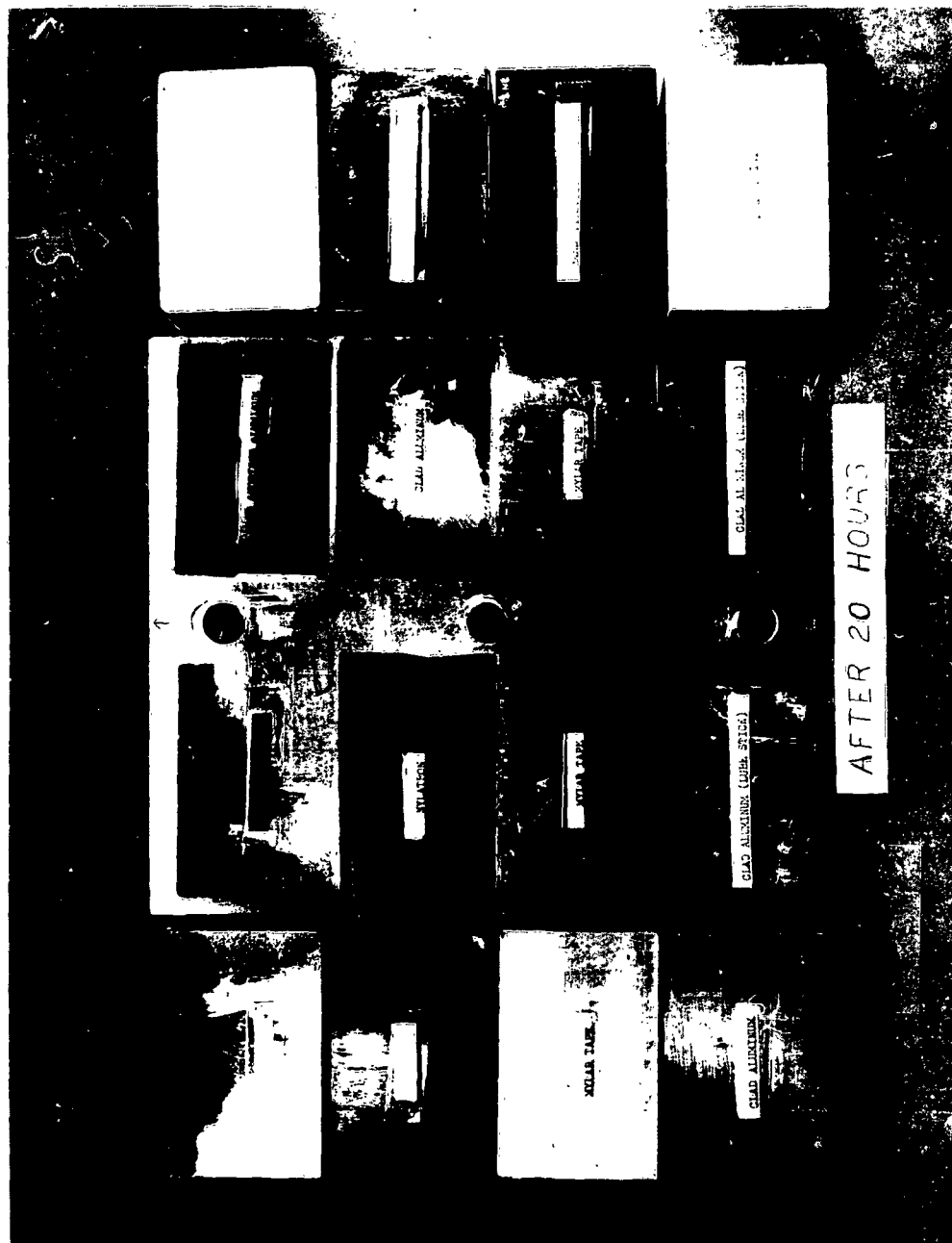


FIGURE 2
CONDITION AFTER 20 HOURS

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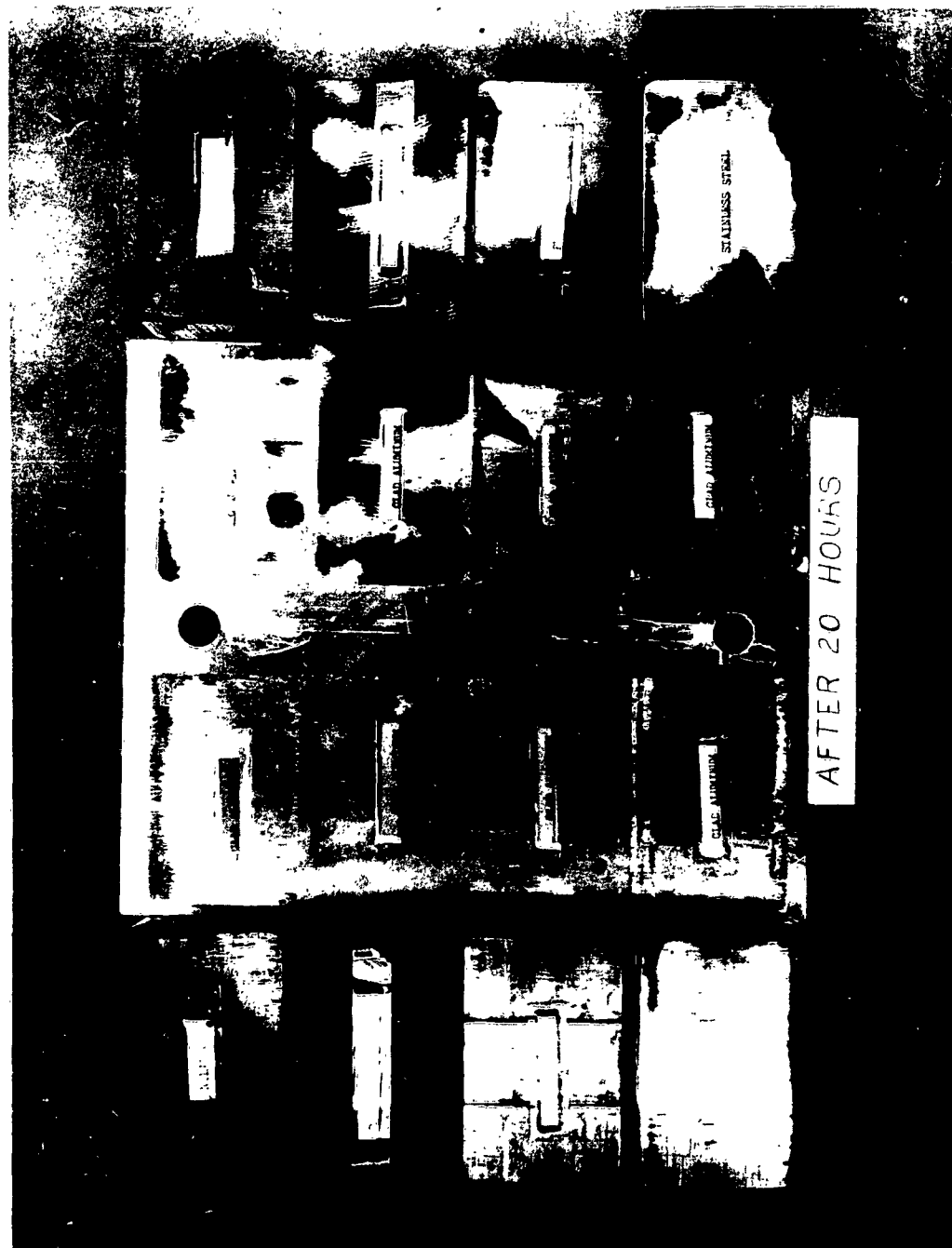


FIGURE 3
CONDITION AFTER 20 HOURS

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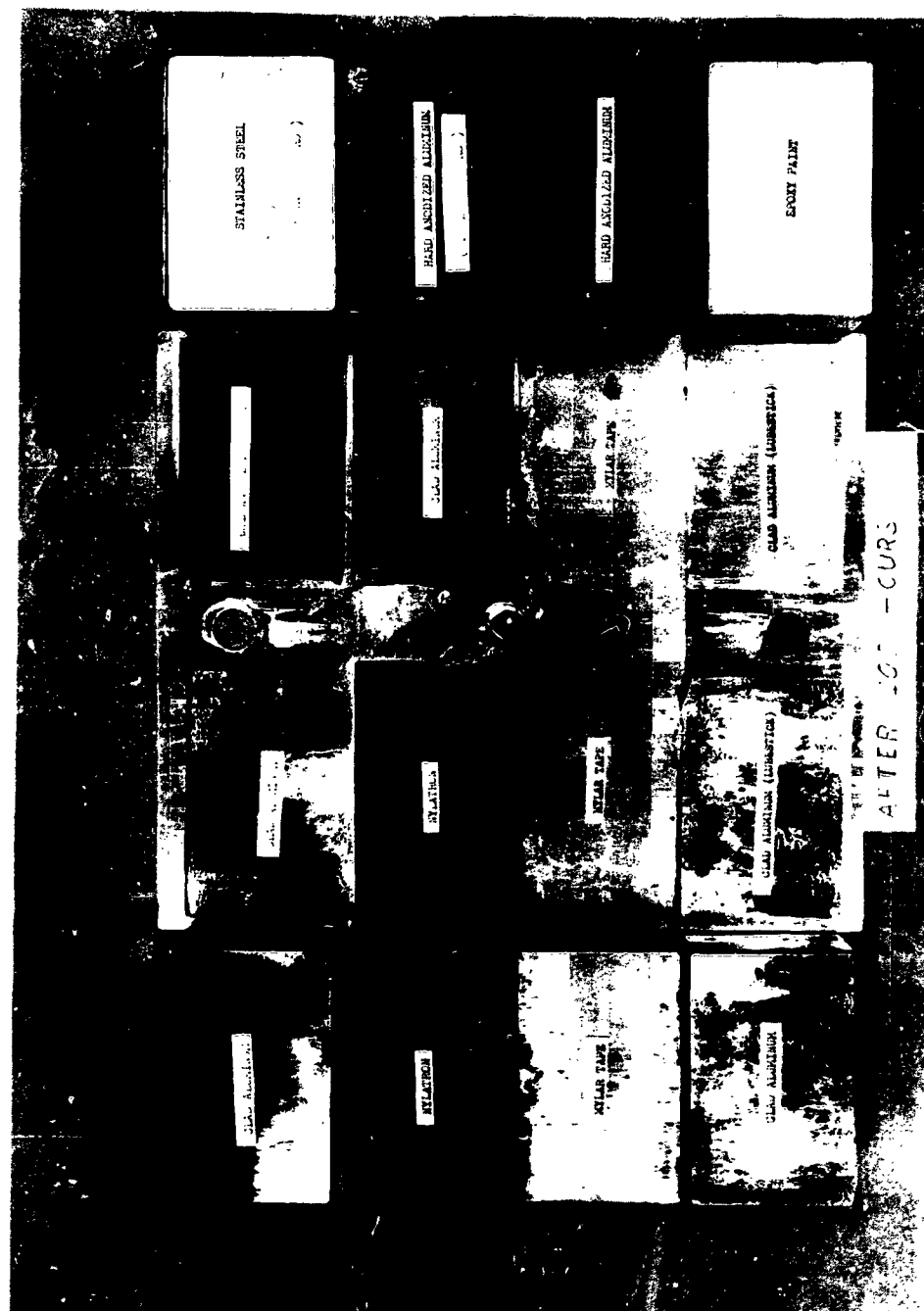


FIGURE 4
 CONDITION AFTER 100 HOURS

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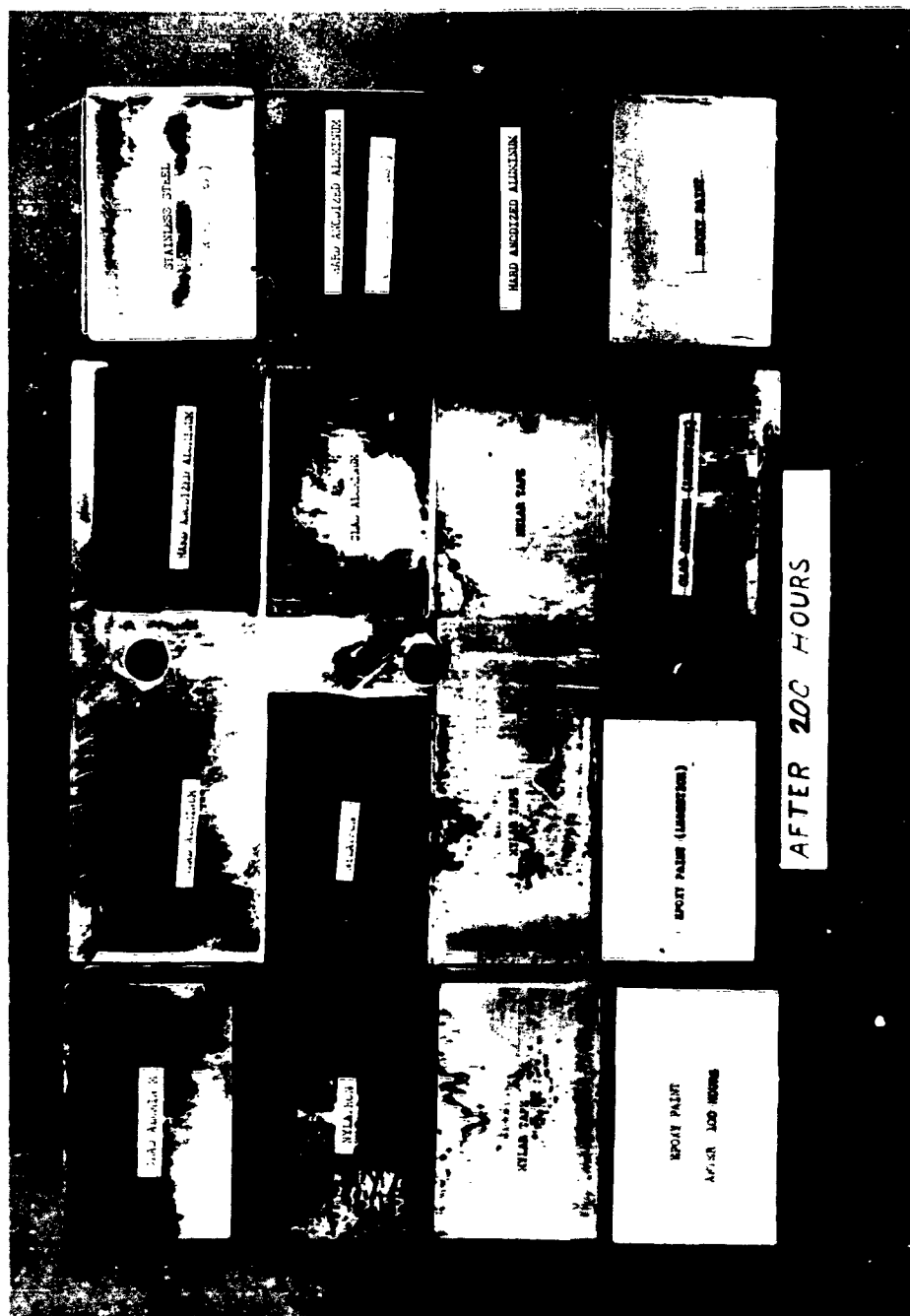


FIGURE 6

CONDITION AFTER 200 HOURS

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FIGURE 7

CONDITION AFTER 200 HOURS

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FIGURE 8

CONDITION AFTER 300 HOURS

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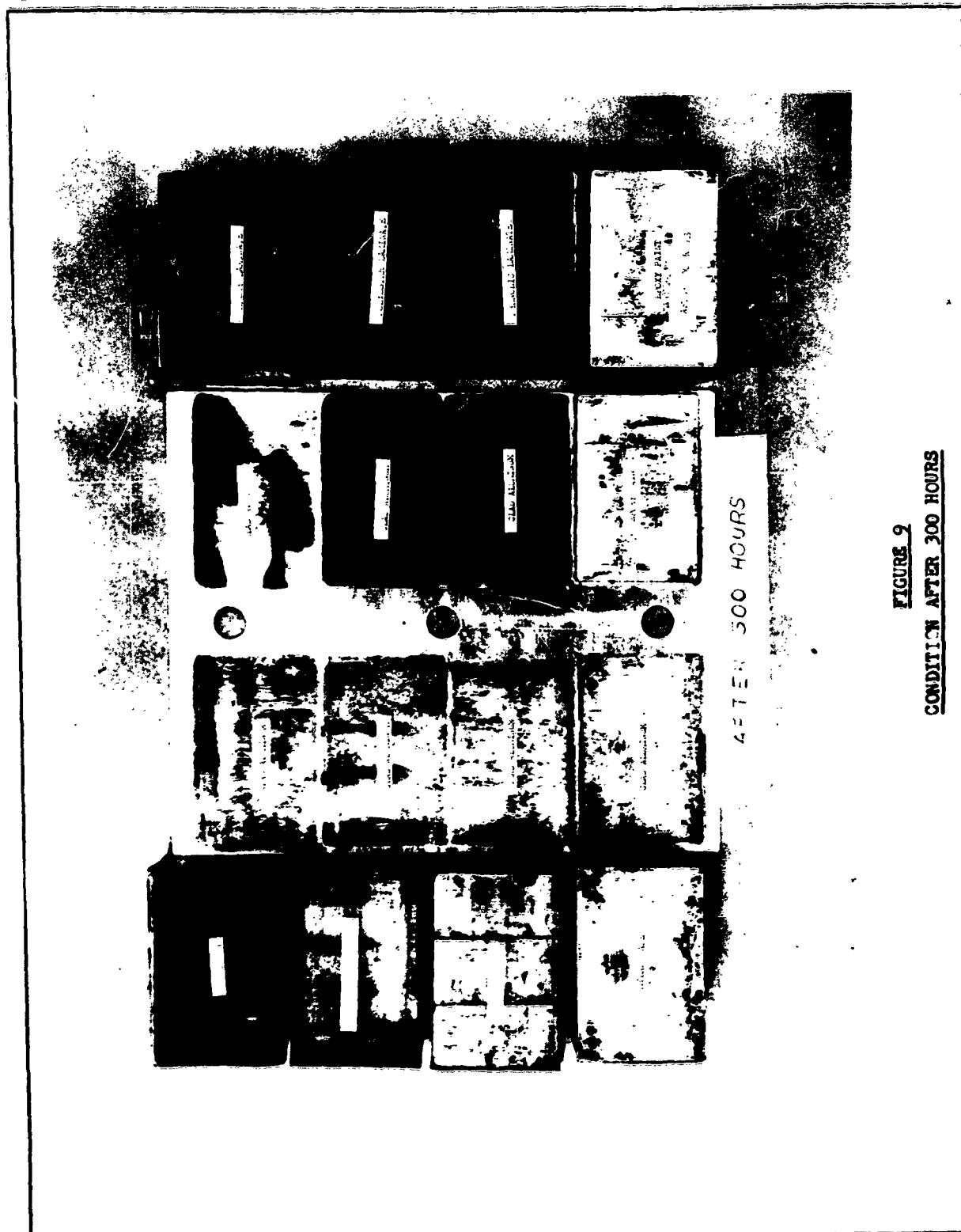


FIGURE 9
CONDITION AFTER 300 HOURS